OF 2001-3

Open File

New Nouveau
Brunswick

Natural Resources and Energy
Minerals and Energy

Geology, Development History, and Exploration Alternatives for Gypsum near Plaster Rock (Part of NTS 21 J/14), Victoria County, Northwestern New Brunswick

T.C. Webb

ISSN 1205-7150
ISBN 1-55236-771-1
Price: $15.00

2002

Open File 2001-3

Geology, Development History, and Exploration Alternatives for Gypsum near Plaster Rock (Part of NTS 21 J/14), Victoria County, Northwestern New Brunswick.

Recommended citation:

WEBB, T.C. 2001. Geology, development history, and exploration alternatives for gypsum near Plaster Rock (part of NTS 21 J/14), Victoria County, northwestern New Brunswick. New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division, Open File 2001-3, 29 p.

Prepared by:

Minerals and Energy Division
Department of Natural Resources and Energy
Province of New Brunswick

Hon. Jeannot Volpé
Minister of Natural Resources and Energy

January, 2002

New Nouveau
Brunswick

Natural Resources and Energy
Minerals and Energy

Open File 2001-3

Geology, Development History, and Exploration Alternatives for Gypsum near Plaster Rock (Part of NTS 21 J/14), Victoria County, Northwestern New Brunswick

T.C. Webb

ISSN 1205-7150
ISBN 1-55236-771-1
Price: $15.00

2002

TABLE OF CONTENTS

	Page
ABSRACT / RESUME	iii
Introduction	1
General location	1
General physical setting and access	1
Local landscape features	3
General land use	3
General Geology	3
Detailed Geology	4
Deposit Type	8
Exploration and Development History	8
Preliminary Deposit Assessment	12
Salt Brook	15
Renous Highway	15
Fraser "Haul" Road-Burntland Brook	15
Conclusions	15
Acknowledgements	17
Bibliography	19

APPENDICES

A. Table of compiled chemical analyses from typical gypsum samples from the Plaster Rock area, northwestern New Brunswick. 25

B. Summary of drilling activity on the "Airport Property" east of the Village of Plaster Rock, northwestern New Brunswick 26

C. Map Plate 2001-25. Carboniferous geology and gypsum resources of the Plaster Rock area (part of NTS 21 J/14), Victoria County, northwestern New Brunswick 29

TABLES

PAGE

1. Summary of formations for the Plaster Rock Basin and adjacent areas, Victoria County, northwestern New Brunswick 6

ILLUSTRATIONS

1. Red shale and siltstone with thin beds and nodules (porpyroblasts) of gypsum, exposed on the east bank of the Tobique River adjacent the Village of Plaster Rock, Victoria County, northwestern New Brunswick 1

2. Location and general geology of the Plaster Rock map area, Victoria County, northwestern New Brunswick 2

3. Typical nodular limestone of the Plaster Rock Formation exposed on the east bank of the Tobique River near the mouth of Salt Brook, about 500 m north of Fraser Paper's lumber mill and related operations at Plaster Rock Station 5

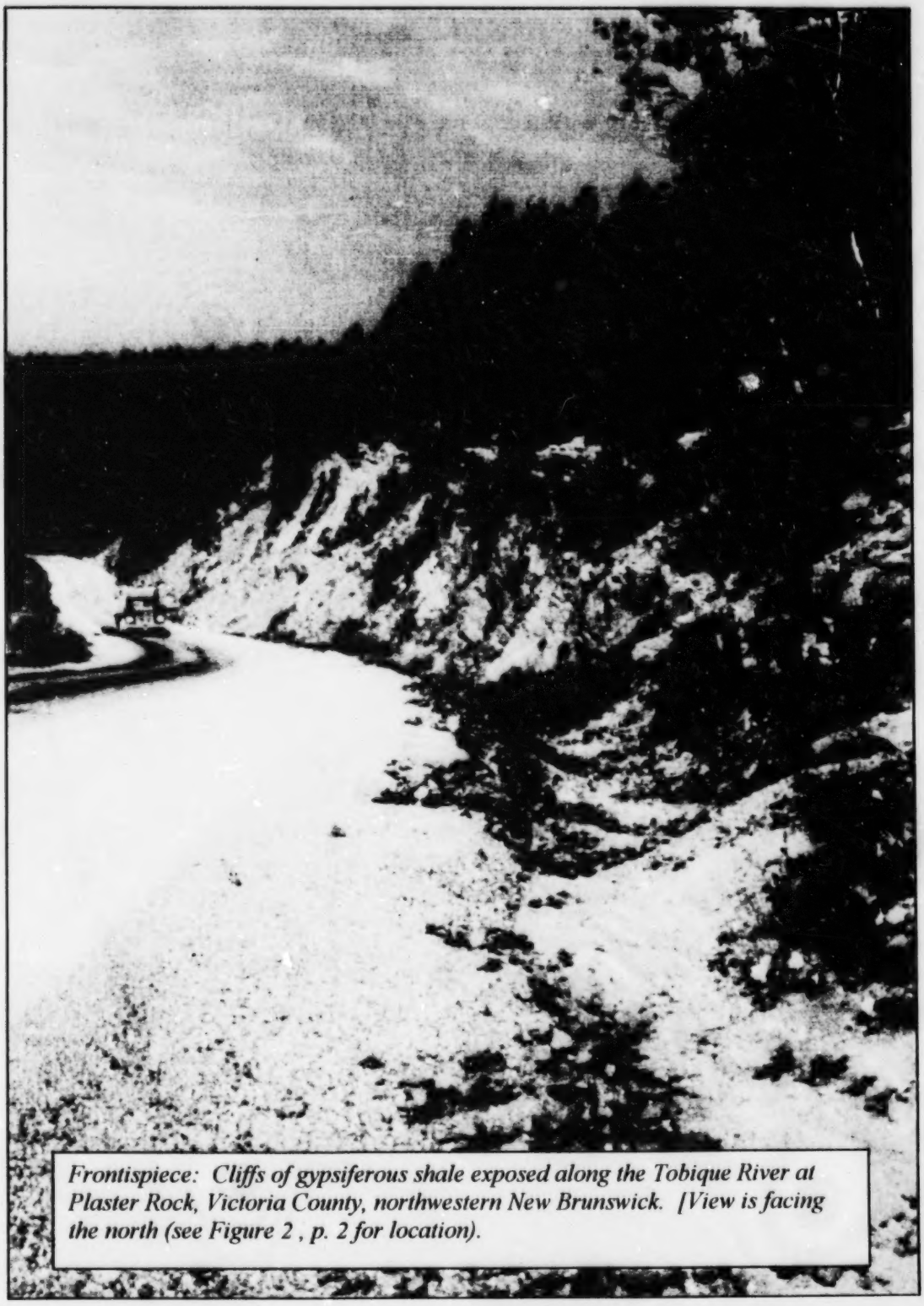
4. Typical thin bedded gypsum and porphyroblastic to nodular gypsum, dispersed in a red gypsiferous shale (4a) and massive gypsum with associated red shale (4b) of the Plaster Rock Formation , one to two kilometers east of the Village of Plaster Rock, northwestern New Brunswick 7

5. General geologic model depicting a depositional synthesis of calcium sulphate and related evaporite deposits of the Plaster Rock Formation near the Village of Plaster Rock, northwestern New Brunswick 9

6. Drilling activities at the Airstrip gypsum property a few kilometers east of the Village of Plaster Rock, Victoria County, northwestern New Brunswick. (6a) An air-track drill rig customized to a coring rig provides a means of acquiring preliminary subsurface data on the gypsum resource (6b) Some massive zones of white, high-quality gypsum are found intermixed with zones of shaley, red low- to medium-quality gypsiferous material and (6c) typical drill core of massive, white higher quality gypsum intersected locally at the Airstrip gypsum property. 13

7. Establishing the processing facility of Plaster Rock Gypsum and Manufacturing (October 2000) 13

8. Subsurface textural variations in clastic sedimentary rocks and distribution of contained $CaSO_4$ deposits affects ground water flow, sulphate dissolution and subsequent development of karst terrain 16



Frontispiece: Cliffs of gypsiferous shale exposed along the Tobique River at Plaster Rock, Victoria County, northwestern New Brunswick. [View is facing the north (see Figure 2 , p. 2 for location).

ABSTRACT

Near surface deposits of gypsum ($CaSO_4 \cdot H_2O$) and gypsiferous shale are well exposed a few kilometers east of the Village of Plaster Rock in northwestern New Brunswick.

The calcium sulphate rocks belong to the Early Carboniferous, Mabou Group, part of a sequence of terrestrial clastics, carbonates, and evaporites collectively referred to as the Plaster Rock Formation. Deposits of gypsum, gypsifeorus shale and related fine-grained clastic sedimentray rocks, extend over 100 km^2 near the structural center of the Plaster Rock Basin.

Gypsum is generally found in irregular, lensy beds, 0.5 cm to 1 m thick, seldom extending more than a few tens of meters in length. These beds are interbedded with gypsiferous shale containing coelescing gypsum porphyroblasts, and narrow veins of fibrous satin spar. Depending on location the general quality of the gypsum resource in the region is generally in 80 to 90% ($CaSO_4 \cdot H_2O$) range.

Gypsum deposits in the region have a history of limited production, supplying primarily agricultural material (land-plaster) to the local farming community in northwestern New Brunswick and the northeastern part of the State of Maine and cement raw material to the Montréal area. These early enterprises came to an end by the early 1930's. An attempt is currently underway to revive an agricultural gypsum operation near these former production sites.

Consideration of other potential gypsum exploration targets in the Plaster Rock Basin is hindered by a lack of adequate outcrop. However, there remain a few areas in the vicinity of Flat Top Mountain, in the west-central part of the basin, where surface landscape features indicate unqualified potential for a near surface gypsum resource.

RÉSUMÉ

Des gîtes subaffleurants de gypse ($CaSO_4 \cdot H_2O$) et de schiste gypsifère affleurent de façon évidente à quelques kilomètres à l'est du village de Plaster Rock, dans le Nord-Ouest du Nouveau-Brunswick.

Les roches de sulfate de calcium sont rattachées au groupe du Carbonifère inférieur de Mabou, qui fait partie d'une séquence d'évaporites, de carbonates et de roches clastiques terrestres collectivement appelées la Formation de Plaster Rock. Les gîtes de gypse, de schiste gypsifère et de roches sédimentaires clastiques à grain fin apparentées s'étendent sur plus de 100 kilomètres carrés près du centre structural du bassin de Plaster Rock.

Le gypse est généralement présent dans des strates lenticulées irrégulières de 0,5 cm à 1 m d'épaisseur, qui s'étendent rarement sur plus de quelques dizaines de mètres de

longueur. Ces strates sont interlitées de schiste gypsfère renfermant des porphyroblastes de gypse coelescent et des filons étroits de spath satiné fibreux. Selon l'endroit, la qualité générale des ressources en gypse dans la région varie généralement parmi une fourchette de 80 à 90 % ($CaSO_4 \cdot H_2O$).

Les gîtes de gypse de la région ont fait l'objet d'une production limitée par le passé, alimentant principalement en produits agricoles (plâtre pour l'agriculture) le milieu agricole local du Nord-Ouest du Nouveau-Brunswick et du Nord-Est de l'État du Maine, et alimentant la région de Montréal en matière première pour ciment. Ces premières entreprises ont cessé de fonctionner au début des années 30. On tente présentement de relancer une exploitation de gypse agricole près de ces anciens lieux de production.

La considération d'autres objectifs d'exploration de gypse éventuels dans le bassin de Plaster Rock se trouve gênée par l'absence d'affleurements adéquats. Il reste cependant quelques endroits à proximité du mont Flat Top dans le centre-ouest du bassin, où les particularités du paysage de surface révèlent un potentiel sans réserve de ressources subaffleurantes en gypse.

103-00446

Geology, development history, and exploration alternatives for gypsum near Plaster Rock, (part of NTS J/14), Victoria County, northwestern New Brunswick

Introduction:

General Location: Gypsum and gypsiferous shales of Carboniferous age are prominently exposed along the eastern bank of the Tobique River adjacent the Village of Plaster Rock (Figures 1and 2) in northwestern New Brunswick.

Figure 1. Red shale and siltstone with thin beds and nodules (porphyroblasts) of gypsum, exposed on the east bank of the Tobique River adjacent the Village of Plaster Rock, Victoria County, northwestern New Brunswick.

Plaster Rock, a community of about 1300 people, serves as a western gateway to an extensive wilderness area of north-central New Brunswick. The village is linked to the Saint John River Valley area and the northwestern portion of the Trans-Canada Highway (Rte. # 2) via three prominent arterial highways: two (Rte. #109 and Rte. 390) connecting with the Town of Perth-Andover, 40 km to the southwest and another with the Town of Grand Falls, about 35 km to the northwest. For over a century Plaster Rock's economy has been directly associated with the forestry sector. One of the Province's largest lumber mill operations has had a well-established presence in the community for several decades.

The paved southwest-northeast-trending Renous Highway (Rte. #108) and the private main forest haul road of the Fraser Paper Company along with its adjacent network of logging roads provide reasonable access to the eastern and southern parts of the area considered underlain by gypsiferous strata. Access to its northwestern part is unfortunately limited and somewhat problematic at the present time.

General physical setting and access: The gypsiferous deposits near the Village of the Plaster Rock occur immediately east of the Tobique River in an area characterized by a generally flat to gently undulating topography. With one notable exception, elevations throughout the region range from 160 to

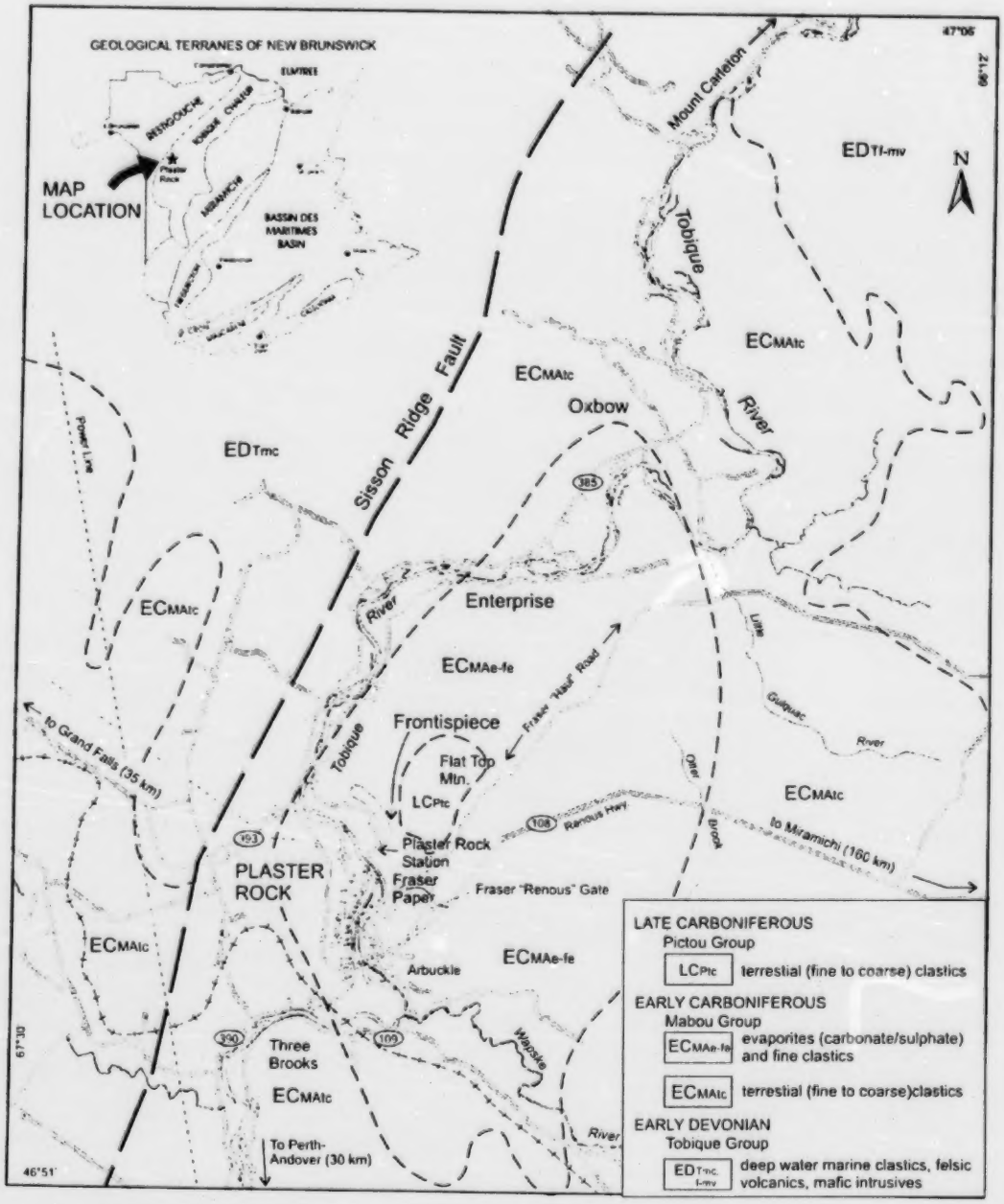


Figure 2. Location and general geology of the Plaster Rock map area, Victoria County, northwestern New Brunswick.

170 m above sea level and gradually rise to 210 m near the proposed eastern limits of the deposit. Less than a kilometer east of the Tobique River at Plaster Rock Station, a north-south trending, 250 m-high plateau locally referred to as Flat Top Mountain extends over a 4 to 5 km^2 area.

Several small brooks flowing north and west into the Tobique and south into the Wapske River provide the most prominent drainage network in the region. Low-lying swamp and related wetland is generally limited to the northwestern part of the proposed gypsiferous terrain.

Local landscape features: Except for a cliff section extending 500 m along the east bank of the Tobique River near Plaster Rock Station, gypsiferous rocks are generally not very well exposed in the Plaster Rock area. In most cases their subsurface presence is displayed locally through the development of a natural karst terrain. This landscape is characterized by an irregular to hummocky surface topography with numerous water-filled and sometimes dry, closed, steep-sided depressions, caused by the dissolution, abrasion and subsequent collapse of soft, underlying gypsiferous bedrock. These surface features are particularly well developed near the former Plaster Rock airstrip at Arbuckle, near Tamarack and Elbow lakes, 3.5 km further east and adjacent a north-flowing tributary of Fullerton Brook east of Flat Top Mountain and about 500 m north of the main Fraser "Haul" Road.

General land use: With few exceptions much of the area considered underlain gypsiferous material is wilderness and part of the Tobique Regional Recreational Area. A large portion of this area is owned and managed by Fraser Paper and related companies. Although parts have been logged and reforested only a small portion of the area considered underlain by gypsiferous material currently supports active industrial (*i.e.* Fraser Paper's lumber operations) and recreational (*i.e.* the Plaster Rock Golf Course and the Flat Top Mountain, 20 km trail system) activities.

General Geology:

Prior to the mid-1930's the "celebrated plaster cliffs" (Hind 1865) adjacent the Tobique River near Plaster Rock attracted the casual interest of geologists. Bruce Rose, of the Geological Survey of Canada (GSC) mapped the area in 1935 and incorporated the region's gypsum and associated limestone resources into a regional geological map accompanied by a preliminary report (Rose 1936). Thirty-five years later the Plaster Rock deposits were integrated into several regional mapping projects, undertaken by Ralph Skinner of the GSC, several kilometers east of the village (Skinner 1971, 1975 and 1982). Mapping by provincial Department of Natural Resources (DNR) geologists, C. St. Peter (1978, 1979 and 1981) and R. Irrinki (1977a and 1977b) have also contributed to the geological understanding of the region.

In the late 1970's and early 1980's Les Davies and Les Fyffe brought-together the earlier work by DNR staff and others producing a series of regional geological compilation maps (Davies 1979; Fyffe 1982a, 1982b and 1982c).

The Plaster Rock calcium sulphate and associated evaporite deposits are exposed near the structural center of an elliptical-shaped, northeast-trending structural basin referred to as the Plaster Rock Basin. Covering approximately 1125 km^2 the basin contains a mixed assemblage of sedimentary and volcanic rocks.

For the most part the Plaster Rock Basin is situated within the Tobique-Chaleur tectono-stratigraphic zone, extending 200 km northeast from the Woodstock area to the Upsalquitch Forks region in the northwestern New Brunswick (see inset, Figure 2*)*. The Tobique-Chaleur zone is underlain by Silurian carbonate and siliciclastic sedimentary rocks of the Perham Group (Boucot et al. 1964; Roy and Mencher 1976; Fyffe 1982d) and Siluro-Devonian sedimentary, bimodal volcanic and minor intrusive rocks belonging to the Tobique Group (St. Peter 1978, 1979; Fyffe 1982d). Tobique rocks are unconformably overlain by Lower to Upper Carboniferous volcanics, terrigenous clastics, carbonates and related evaporites of the Mabou Group (New Brunswick Department of Natural Resources and Energy 2000). Deposits of limestone and gypsum are situated near the structural center of the basin.

Detailed Geology:

The Mabou rocks of the Plaster Rock Basin are divided into three formations (St. Peter 1979). From the oldest to the youngest, they are the Gladwyn Basalt, the Arthurette Redbeds, and the Plaster Rock Formation (Table 1 and Map Plate 2001-25, Appendix C).

An angular unconformity separates the Carboniferous rocks in the region (i.e. Galdwyn Basalt and the Arthrette Redbeds) from the underlying Lower Devonian sedimentary, volcanic and intrsuive rocks of the Tobique Group.

The Gladwyn Basalt is restricted to an area of faulted terrain near the southwestern end of the Plaster Rock Basin, near the community of Gladwyn. St. Peter (1979) describes the basalt as a grayish black, fine-grained rock with an estimated thickness of 30 m. The rock's textural features vary from amygdaloidal to porphyritic. Phenocrysts, constitute 10 to 15 % of the rock mass, consisting of mostly plagioclase (labradorite) with lesser amounts of clinopyroxene. The aphanitic to fine-grained matrix (50 to 85%) is composed of plagioclase, calcite, and an opaque mineral, with minor clinopyroxene, chlorite, sphene, apatite and quartz. Vesicles in the amydaloidal variety contain analcime, quartz and calcite (St. Peter 1979). Locally, the rocks display a network of subhorizontal to upright joints (*eg.* columns).

The Arthurette Redbeds comprise the most widespread Early Carboniferous terrestial clastic sedimentary strata in the Plaster Rock Basin. This sequence of coarse- to medium-grained clastic sedimentary rocks is conformable with the underlying Gladwyn Basalt. Where the basalt is absent, their contact with older rocks of the Tobique Group is a marked unconformity.

Arthurette strata typically consist of an interbedded sequence of red conglomerate and sandstone with minor red mudstone. The conglomerate is typically polymictic, containing a

heterogeneous mix of sedimentary and volcanic rocks, along with clasts quartz and feldspar set in a muddy to sandy feldspathic matrix. Regionally, finer-grained rocks tend to dominate lithologies in the southern part of Plaster Rock Basin, whereas coarse-grained sedimentary clastics are more prevalent in its northern half. The mudstone and fine-grained sandstones generally found in the Plaster Rock-Arthurette area are thin to thick bedded with local concentrations of pinkish grey, nodular limestone.

In the northern of the basin, near the Renous gate to Fraser Paper's woodlands east of Plaster Rock, the Aurtherette Redbeds are characterized by a conglomerate dominated by grey to red grey laminated limestone and siltstone clasts in a coarse-grained sandy matrix.

The Plaster Rock Formation overlies the Arthurtte Redbeds and is restricted to the structural center of the basin. It is subdivided into a lower, predominantly limestone unit associated with interbeds of red shale and mudstone, a middle unit of gypsiferous siltstone and shale with local occurrences of massive gypsum, and an upper unit of *"red shale with sandstone lenses"* (Rose 1936). Rose estimated the thickness of these various units at 130, 100 and 800 feet (40, 30 and 244 m) for the limestone, gypsum and shale units respectively. St. Peter (1979), who grouped the uppermost shale unit in with the underlying gypsiferous strata reports an estimated thickness of 150 to 300 meters.

The limestone-shale unit is exposed in scattered outcrops a few kilometres east and southeast of the Village of Plaster Rock. The limestone is greenish grey to reddish brown, very fine-grained and massive to nodular. The nodular type occurs in lenticular beds ranging in thickness from 1 to 20 cm. Nodules are generally enveloped by red and green shale. Where shale dominates the lithology, the limestone has a red, streaky to mottled, red to grey appearance. An outcrop near the mouth of Salt Brook on the east bank of the Tobique River exhibits features considered typical of the facies relationship between the various lithologies that make up this limestone-clastic unit (Figure 3).

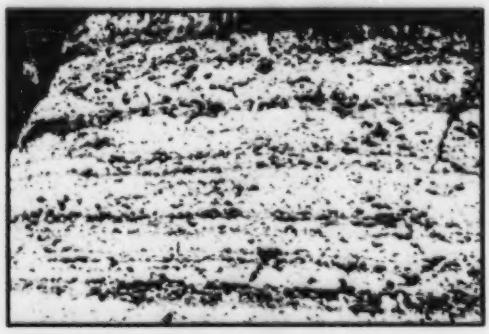


Figure 3. Typical nodular limestone of the Plaster Rock Formation exposed on the east bank of the Tobique River and near the mouth of Salt Brook, 500 m north of Fraser Paper's lumber mill and related operations at Plaster Rock Station .

At this location shallow-dipping massive limestone beds up to 10 cm thick grade laterally and vertically into nodular limestone with abundant disseminated and interbedded shale. The limestone nodules are interpreted to have a diagenetic origin, [*i.e.* the product of calichification (St. Peter 1979)].

Gypsiferous red shale and grey to white massive gypsum with interbedded red,

ERA	PERIOD	GROUP	FORMATION	MAP UNIT	LITHOLOGY
PALEOZOIC	Late Carboniferous	Pictou?		Pcc	Red conglomerate and sandstone
	Unconformity				
	Early Carboniferous	Mabou	Plaster Rock	PRfc	Red shale, mudstone, siltstone, and fine-grained sandstone
				PRg	Red and green shale and mudstone, gypsiferous shale and siltstone and massive gypsum
				PRls	Red shale , mudstone and siltstone with nodular to massive limestone
			Arthurette Redbeds	ARcc	Red sandstone, conglomerate, minor red mudstone and buff to grey quartz-pebble conglomerate and sandstone
			Gladwyn Basalt	GBmv	Greyish black, amydaloidal basalt
	Unconformity				
	Early Deveonian	Tobique		Tmfvs	Mafic intrusives, felsic and mafic volcanics and grey lithic sandstone, quartzose sandstone, siltstone and slate

Table 1. Summary of formations for the Plaster Rock Basin and adjacent areas, Victoria County, northwestern New Brunswick (modified from St. Peter 1979).

shale, siltstone and fine-grained sandstone overlie the limestone-shale unit. Although not well exposed, typical lithologies can be seen along the banks of the Tobique River, in the vicinity of an abandon air strip, just east of Plaster Rock and north of Wapske (Figures 4a and 4b).

Figure 4a. Typical thin bedded gypsum and porphyroblastic to nodular, low quality gypsum dispersed in a red gypsiferous shale of the Plaster Rock Formation from Tobique River cliff-face exposures, near the Village of Plaster Rock in northwestern New Brunswick.

Elsewhere, areas characterized by numerous dry and water-filled sinkholes provide a surface expression of underlying gypsiferous strata in this part of the Plaster Rock Basin. The gypsum-bearing unit has an estimated thickness of 40 m (Hamilton and Barnett 1970) with individual gypsum dominated strata varying in thickness from a few centimeters to about 1 m, rarely exceeding 2 m. Massive beds of gypsum, less abundant than the shaly to silty material, occur in white to grey to reddish beds, varying in thickness from less than a centimeter to about 1 to 2 m (Figure 4b). The more common mode of occurrence for gypsum deposits in the region is gypsum porphyroblasts scattered in a matrix of red gypsiferous shale and siltstone (Figure 4a). Gypsum also occurs as fibrous satin spar in 1

Figure (4b). Massive, high quality gypsum with disseminated red shale of the Plaster Rock Formation. Exposure is one to two km east of the Village of Plaster Rock in northwestern New Brunswick

to 5 cm-wide veins, often orientated parallel to sub-parallel to bedding in shaley host rocks.

Textural differences ranging porphyroblastic gypsum in a fine-grained clastic matrix and the infrequent occurrence of massive, gypsum would suggest two contrasting depositional processes contributed to formation of gypsum bearing strata in the Plaster

Rock area. The porphyroblastic type shows a slight discordance between the shale and gypsum bedding planes suggesting it is probably of diagenetic origin (St. Peter 1979). It would seem that most of the gypsiferous material of this type resulted from intrasediment precipitation, creating both displacive and incorporative masses of gypsum crystals in a muddy to silty host rock. This contrasts the precipitation of massive homogenous sulphate on the surface of such clastic material from isolated ponds or related standing bodies of water.

In the west-central part of the Plaster Rock Basin the carbonate-sulphate sequence is overlain by red conglomerate and sandstone. Fragments of fossilized plant material (*i.e.* calamites) identified in float from the area suggest an Upper Carboniferous age for these rocks. Although the true nature of the contact between Lower and Upper Carboniferous strata in the area is not seen it is suggested that it may be unconformable considering the lithologic contrast between predominantly fine-to coarse-grained clastics. Rose (1936) suggested that the *"upper conglomerate"*...may be the basal member of another series".

Carboniferous strata throughout most parts of the basin display little to no evidence of deformation. Beds seldom dip more than 15 degrees. A few northeasterly-trending faults offset Carboniferous strata along the western perimeter of the basin. The recognition of related structures within the basin is hampered by a general lack of suitable bedrock exposure.

Deposit type:

Gypsum and associated limestone deposits of the Plaster Rock area are considered to be of Lower Carboniferous age (St. Peter 1979). They appear to have formed under semi-arid climatic conditions in a continental, fluvial overbank to playa mudflat to lacustrine depositional setting associated with local volcanic emanations, near the distal portion of an alluvial fan complex (Figure 5).

The region's carbonate and sulphate resources are generally characterized by diagenetic limestone (caliche), and gypsum and gypsiferous shale (gypcrete). Groundwater enriched in carbonate and sulphate ions apparently became increasingly concentrated as it progressed across the mud flat environment to a series of interconnected ponds and small lakes, resulting in the eventual nucleation of carbonate and sulphate into nodules and the subsequent formation of lenticular beds of more massive material.

Exploration and Development History:

Among the earliest recorded comments regarding the gypsum deposits in the Plaster Rock area are those made by L.W. Bailey in 1864. While reporting on the "Mines and Minerals" in the Province (Bailey 1864), Bailey stated that *"Although well known, I cannot refrain in my allusions to the Tobique from referring to the immense beds of gypsiferous sandstone"*...[describing

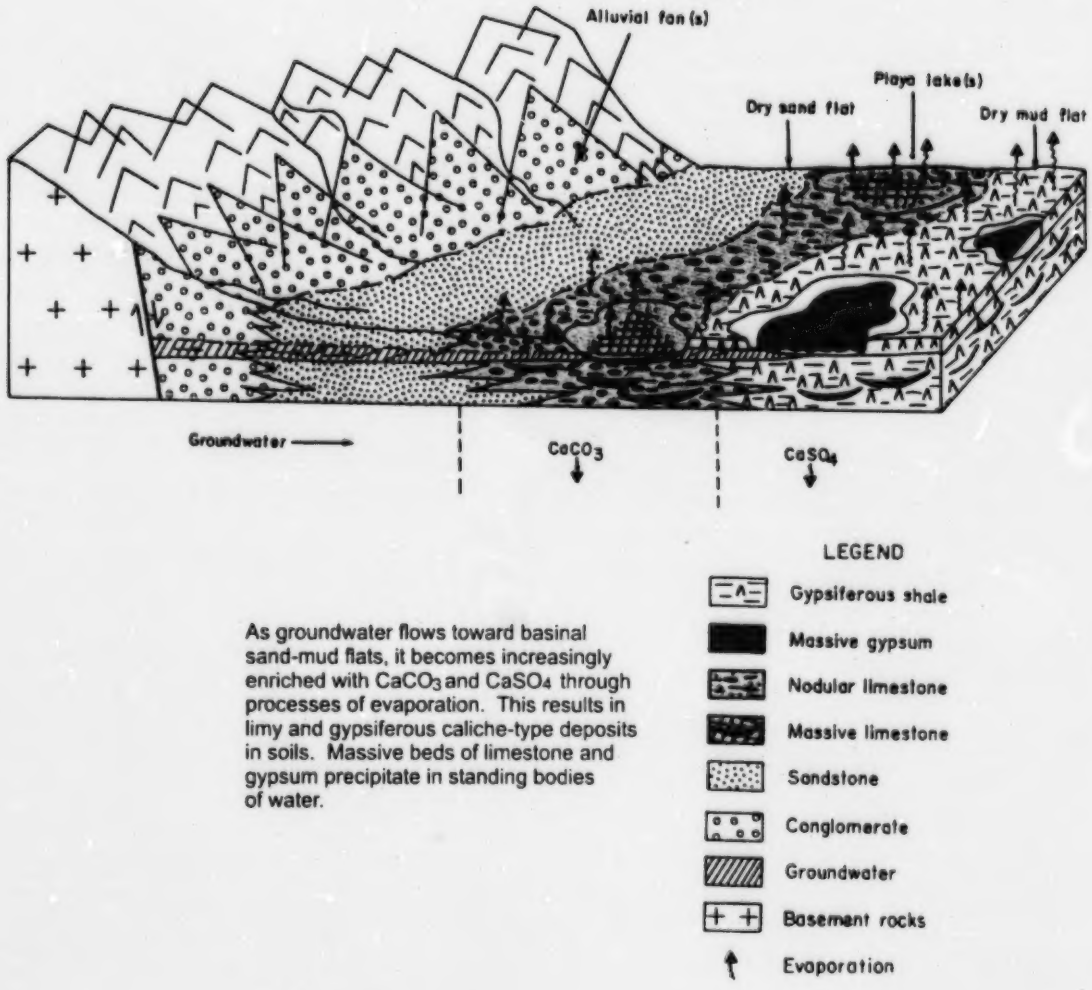


Figure 5. General geologic model depicting a depositional synthesis of calcium sulphate and related evaporite deposits of the Plaster Rock Formation near the Village of Plaster Rock, northwestern New Brunswick (Webb and Venugopal 1992).

them as high cliffs of]... "*white, red and variegated gypsum, gypsiferous sandstone and red conglomerate*". It also seems that Bailey was particularly impressed by its [gypsum] "*great purity*" near the junction of the Wapske and Tobique rivers. As a general comment he referred to the material [as] "*...excellent* [quality] ... *requiring adventurous hands to remove it from those shelving precipices*", suggesting that commercial development of the resource at that time was probably not underway.

The first mention of any gypsum

production from the area was that reported from a small quarry and grinding mill located on the east bank of the Tobique River, about 1.5 km north of its confluence with its tributary, the Wapske River (Map Plate 2001-25, Appendix C). This business is thought to have been operated by a John Edgar, utilizing the gypsum resource to supply the fertilizer or land plaster needs of the local farming community (Bailey and Jack 1880). There are few details pertaining to this early enterprise except that it was probably in operation prior to 1880 according to Ells who reported *"a mill for grinding it [gypsum] for agricultural purposes has lately been erected on the Tobique"* (Ells 1881).

During a return visit to Plaster Rock in 1884-85, Bailey conveyed that the area's gypsum was being used *"solely for agricultural purposes and* [that] *considerable quantities were being used in this way"*, both locally, and along various parts of the St. John River Valley, served by the New Brunswick Railway (Bailey 1885). Comparing it to the plaster-quality gypsum mined at Hillsboro in the southeastern part of the province, he described *"it is greatly inferior in purity...* [and] *hardly suited for calcination"*.

By 1886, two grinding mills were reported established on the Tobique, one at Three Brooks, 5 km south of Plaster Rock and another at Quaker Brook, about 8 kilometers east of Perth (Bailey and McInnes 1887). Output from these operations was apparently quite limited, a consequence of poor shipment practices, which was limited by the number of available [horse] teams to haul quarried and crushed gypsum rock to the mouth of the Tobique River and then on to waiting agricultural markets. With plans underway to extend the New Brunswick rail system along the St. John River valley, some 26 miles up the Tobique valley, as far as the Plaster Rock gypsum deposits, it was expected that this carriage problem would soon be improved. Statistics gathered for 1886, 1887 and 1888 show estimates of gypsum production from the area at 1500, 1297 and 3909 tons respectively (Bailey and McInnes 1887; Coste 1888 and Brumell 1888).

As the Tobique railway spur-line neared completion in the early part of the1890s, the region's gypsum resources began to attract attention of those interested in capitalizing on a thriving "land plaster" export market that was developing with the Aroostook County area, in the nearby State of Maine. A new quarry was soon established near Wapske (about 400 m north of the confluence of the Wapske and Tobique rivers) operated by Messrs. McQueen and Stewart of Andover. The Annual report of the Crown Lands Department for 1892 records the establishment of a 560 acre gypsum lease in the Plaster Rock area, although it is uncertain if this was the actual McQueen-Stewart property. Free of duty, small shipments of crude stone were soon dispatched from the Plaster Rock region to Aroostook County where grinding mills had been erected to produce "land plaster" for the county's farmers. Apparently much of this early Aroostook market had been supplied from the Hillsborough area of southern New Brunswick as demand far exceeded the ability of the early Tobique-Plaster Rock enterprises to supply (Stead 1893).

The completion of the Tobique Valley Railway linking the Plaster Rock to the main rail line at Perth in 1893-94 saw the former "John Edgar" operation purchased by the Tobique Valley Gypsum Mining and Manufacturing Company (Limited). New gypsum crushing and grinding machinery was installed near an adjacent railway siding (Bailey 1898). Despite the favorable reception of the product, difficulties soon arose with the railway authority over freight rates and other related issues. Differences were apparently insurmountable as the Tobique property passed into new hands with intentions of resuming operations in 1897 which apparently failed to materialize

Up until 1905 there are few details concerning development of the Plaster Rock gypsum resources. Limited statistical data shows only 819 tons was shipped from the area that year (Ells 1907). In 1907 it was reported that *"during the season of 1906 work at these quarries* [Plaster Rock gypsum quarries] *was mostly suspended"* (Ells 1907). A small quarry about a mile south of the village had apparently been worked for two or three years prior, by the Canadian Pacific Railway Company but was discontinued. Operations were renewed at this site in a small way in by Donald Fraser and Son (s) on behalf of the railway company in 1909, supplying gypsum to a Montreal cement plant (Jennison 1911).

Although gypsum mining in the region proceeded to *"a certain extent"* through 1910 , it was not until 1911, following the acquisition of mining rights [to the former Tobique Valley Mining] by Montreal businessman, Mr. Kennedy Stinson, that the industry showed signs of revival. Operating under the name of the Stinson-Reeb Supply Company, Mr. Stinson reported that...."*On or about April 1, 1911, we started operations at Plaster Rock and have been quarrying and shipping gypsum since that date, and we intend to operate the plant to its full capacity during the present winter. To date we have shipped out over 10 000 tons of crushed gypsum and land plaster. The crushed gypsum has been shipped to Montreal and Ottawa for use in the manufacture of Portland cement. We have shipped land plaster to the experimental farm at Ottawa...We have contracts to supply two fertilizer firms in New Brunswick. We think we have we have somewhat revived the use of land plaster as a fertilizer and we are looking for a larger increase in the sale of this material during the coming year"* (in Annual Report to the Crown Land Dept. 1911). Although the statement above exudes optimism, the enterprise appears to have been short-lived, as no mention is made of it after 1913.

Another operation, the J. E. Stewart workings also were reported to be in operation in the region (Mines Branch # 1908 p. 58) around this time, quarrying and shipping about 1000 tons of gypsum annually. This operation continued to 1917 or later (*in* Annual Report to the Crown Land Dept. 1917)

Over the next decade little appears to have been recorded on any gypsum related mining activity in the Plaster Rock area. Interest in the gypsum business however was renewed once again in 1928 when Donald Fraser opened up a quarry, crushing some 400 tons of rock to be utilized as a fertilizer material for the regions potato crops. Although it was Fraser's intent to

expand his operation it seems to have continued as a relatively small enterprise for only 3 or 4 years.

After the demise of the Fraser operation in the early 1930s, the gypsum resources in the region were to remain virtually undeveloped for almost sixty years. In the late 1980s, Plaster Rock resident, Mr. Dan F. Merrithew became interested in the benefits of gypsum as a fertilizer and set out to resume the production of agricultural gypsum (land plaster) in the area. Mr. Merrithew staked 4 mineral claims near an abandoned air strip east of the village in the vicinity of Little Arbuckle Brook (see map inset on Map Plate 2001-25, Appendix C) in 1990. His early attempts to confirm the extent of the resource were dedicated to overburden removal from various parts of the property. This resulted in the excavation of several trenches, the development of a few small test pits and a reconnaissance drilling program consisting of 11 shallow-depth, air-track holes.

Following these initial investigations, Mr. Merrithew established Plaster Rock Gypsum and Manufacturing Limited (PRGM) in 1992. A preliminary market survey was commissioned to investigate potential gypsum markets available to a Plaster Rock-based gypsum production facility. Encouraged by the report's initial findings, PRGM undertook additional drilling on the property in 1995 to identify and prove reserves of sufficient quality to support a small agricultural gypsum operation. Following some rather resourceful modifications to his air track drilling equipment Mr. Merrithew (Figures 6a, 6b and 6c) completed a 29-hole program (Crosby 1996) with the capability of testing the deposit to a maximum depth of 14 .63 m. Following this exploration, PRGM's four "Airstrip" claims were reduced to two. A business plan describing various aspects of the proposed gypsum operation was subsequently prepared in 1997 (Plaster Rock Mining and Manufacturing 1997) and updated in 1999 by a feasibility study (Fraser 1999). As of 2001, Mr. Merrithew had acquired and put in place several pieces of processing equipment (Figure 6) to produce an agricultural gypsum product for the regional agricultural community. After a 70-year hiatus it appears that production of agricultural gypsum from the Plaster Rock area may soon be resurrected (Figure 7).

Preliminary Deposit Assessment:

Most gypsum exposures within the Plaster Rock Basin are situated near its structural center, a few kilometres east of the Village of Plaster Rock. The best exposed occurrences form prominent cliffs along the Tobique and Wapske rivers just east of the village. Gypsiferous rocks are also exposed in an area near an abandoned airstrip, less than a kilometre from the village at Arbuckle. Elsewhere, the extent of these deposits is largely inferred from the widespread occurrence of karst terrain characterized by numerous dry and water-filled sinkholes extending over an area of about 20 km^2.

Despite a longtime interest, published chemical analysis supporting qualitative assessment of the region's gypsiferous deposits is surprisingly limited. This discrepancy may have originated from the initial impressions of early workers, who observed exposures of reddish-

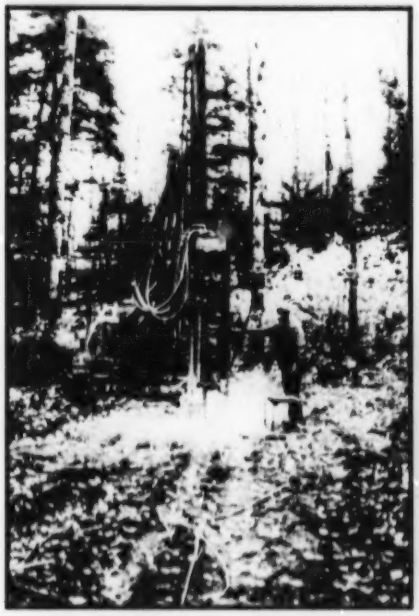


Figure 6a. An air-track drill customized to a coring rig provides a means of acquiring preliminary subsurface data on the gypsum resource.

Figure 6b. Some massive zones of white, high quality gypsum are found intermixed with zones of red low to medium quality gypsiferous material.

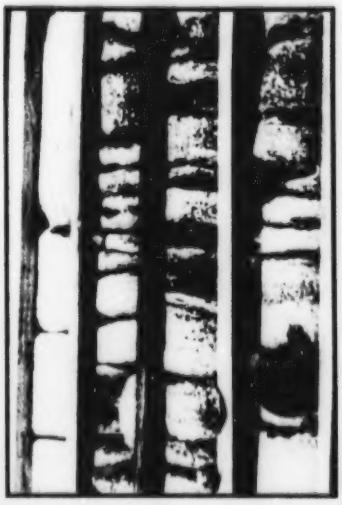


Figure 6c. Typical drill core of massive, white higher quality gypsum intersected locally at the Airstrip gypsum property.

Figure 6. Drilling activities at the Airstrip gypsum property a few kilometers east of the Village of Plaster Rock in northwestern New Brunswick (Mr. Dan F. Merrithew in foreground).

Figure 7. Establishing the processing facility of Plaster Rock Gypsum and Manufacturing (October, 2000).

white, gypsiferous clastic material that some would have considered to be of mediocre quality compared with the higher quality and higher-valued, white, wallboard- and plaster-grade gypsum being mined elsewhere in the New Brunswick. Of the few, available analysis (Appendix A), gypsum contents a kilometre east of the village are shown to reach values into the low 90 per cent range with respect to gypsum.

Since the early 1990's a local company, Plaster Rock Gypsum and Manufacturing Limited (PRGM), has

been evaluating the extent and quality of the gypsiferous deposits east of the village, in the vicinity of a former air-strip. The 32 hectare Airstrip property is considered fairly typical of the resource throughout the region. Basically, two textural types of gypsiferous material are represented here. One type, represented by thin beds (<0.5 m), veins and porphyroblasts of gypsum in association with various proportions of fine-grained clastics. A second type consists of a thick-bedded (0.5 to 2 m), more massive material often interbedded with argillaceous to fine-grained clastic sedimentary rocks.

Over the last decade (1990-2000), PRGM has conducted bulldozer stripping, trenching, test-pitting and has drilled 40 holes on the property (Appendix B). A 1990 drilling program (1990) consisted of 11 randomly spaced air-track holes varying in depth from 2 to 30 m over a 2 to 3 hectare area. Partial chemical analysis carried-out on seventeen drill powder samples are presented in Appendix B. Keeping in mind, contamination caused by the drilling method, most recovered powders were reddish white to reddish brown in color, and seldom exceeded 75% gypsum. However, intervals of white, up to 85% gypsum were intersected in three holes.

Subsequently, a small test-pit was excavated on the property exposing a 3 to 5 m face of gypsiferous material with shaley interbeds. A bulk sample comprising several tonnes was removed and ground into a powder. Chemical analysis were performed on several samples of this material each returning over 85 % gypsum (Crosby 1996).

In 1995, follow-up exploration, including additional overburden removal, test pit enlargement, and drilling was undertaken to further test the extent and quality the gypsum resource on the property. Twenty-nine (29) holes ranging in depth from 6.10 to 14.63 m were drilled at this time using air-track equipment modified to retrieve a core-sample of the underlying bedrock. Unfortunately, overall core recovery was very poor (Appendix B) due to excessive grinding within the drill rods (*i.e.* no core barrel) and the apparent intersection of several underground cavities. Drilling and related results reported by Crosby Consulting and Exploration Services (Crosby 1996) indicate a total drill program of over 360 m of drilling, however only a total of 81 m of core was actually recovered. The gypsum content of all recovered core samples was speculated to (visual estimate) generally exceed 65% (Crosby 1996).

In one area outlined by several drill holes north of the 1990 test pit, Crosby (1996) estimated *"169 000 tonnes at 83% gypsum"*. Following a review of the property by D. M Fraser Services Inc. in 1999, this initial estimate was later expanded to *"391 000 tonnes of gypsum bearing material with an average grade of 86.48% $CaSO_4$"* (Fraser 1999). It must be emphasized that given the poor core recoveries in the majority of drill holes (between 40 and 70 % recovery) and the revelation that the gypsum content of recovered core was visually estimated (Crosby 1996), tonnage must be considered as *"probable geological reserves"* at best. Appropriate measures would be required to upgrade the resource to the accepted definition of a *"proved mineral reserve"* (CIM 1998). It is however, worth noting

reported tonnage estimate is based on results from less than 5 % of the total area of PRGM's Airstrip property. Drilling elsewhere on the property provides sketchy details on the nature and characteristics of the gypsum resource, however, given the depth limitations (maximum 14 to 15 m) and core recovery problems related to the drilling method, there appears to be a reasonable possibility of additional unqualified gypsiferous material in the area.

As for additional gypsum resources within the Plaster Rock Basin, a general reconnaissance of the region has revealed a few areas characterized by hummocky terrain, with associated sinkholes that might serve as reasonable exploration alternatives. These areas are outlined on Map Plate 2001-25 (Appendix C) and include:

*(1) **Salt Brook**:* Cliffs of gypsiferous shale similar to those exposed along the Tobique River near Plaster Rock are found in fairly rugged terrain, 400 to 800 m north of Fraser Inc.'s lumber mill operation east of Plaster Rock Station, adjacent Salt Brook. Accessibility to the area is limited.

(2) ***Renous Highway**:* This area is situated adjacent the Renous Highway (Rte. # 108), 8 to 9 km east of the Arbuckle-Plaster Rock bridge. The most favorable gypsum area is in the vicinity of a large water-filled sinkhole less than 500 m south of the highway. There is also potential for gypsum resources north of the highway. The Renous Highway and adjacent logging roads provide excellent access to most parts of the proposed area.

(3) ***Fraser"Haul"Road-Burntland Brook**:* An area of what appears to be a series of sinkholes, 800 to 1000 m north of where Burntland Brook crosses the main Fraser "haul" road (4 to 5 km northeast of the Fraser sawmill operation at Plaster Rock Station) is also seen as having reasonable potential for gypsiferous deposits. Access is via a network of logging roads that connect with main road.

Conclusions:

Thin beds of massive gypsum are found intercalated and disseminated with zones of gypsiferous siltstone and shale in the middle to upper part of the Plaster Rock Formation near the Village of Plaster Rock in northwestern New Brunswick.

The gypsiferous resources occur near the structural center of the Plaster Rock Basin. The distribution and characteristics of the resource within this area is not well known, resulting from a general lack of exposure. This situation is a consequence of an undetermined thickness of overlying fine-grained clastics in combination with a thick cover of glacial till and the general inaccessibility to the area considered underlain by gypsiferous deposits. One area less than kilometer east and southeast of Plaster Rock near Arbuckle and Plaster Rock Station is an exception to this generality. It is here that gypsum-bearing strata is frequently found outcropping along the Tobique River with adjacent terrain characterized by the development of an extensive karst landscape. This particular area has a history of sporadic gypsum production from the late 1800's to the early 1930's.

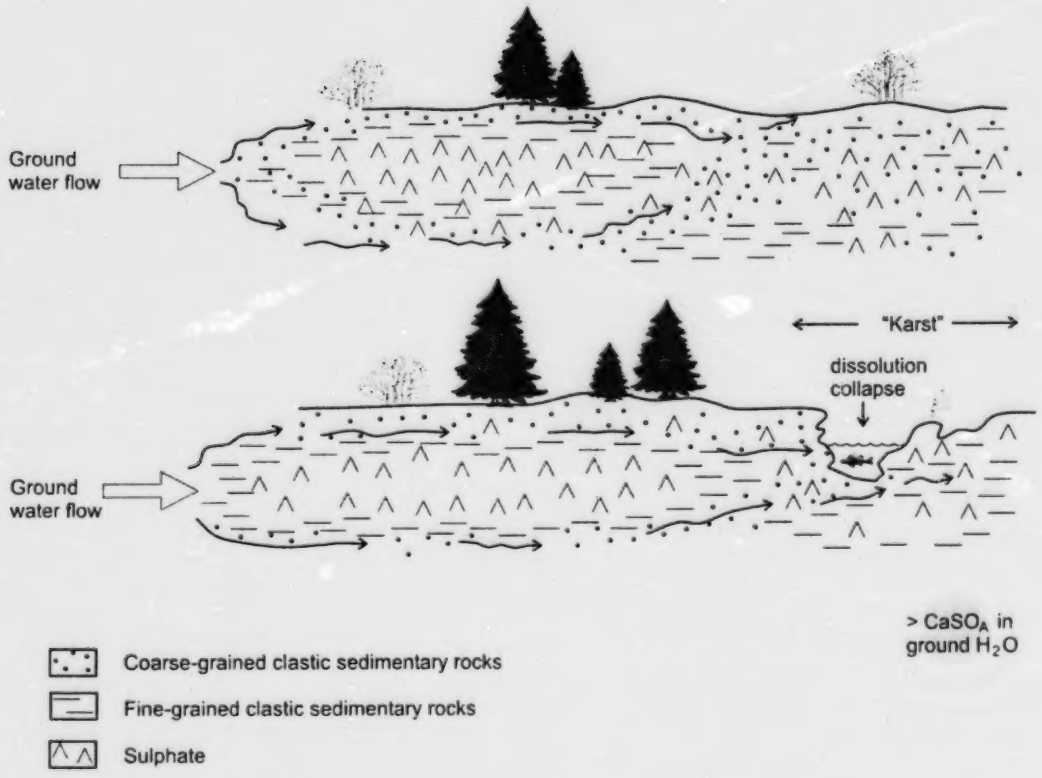


Figure 8. Subsurface textural variations in clastic sedimentary rocks and distribution of contained $CaSO_4$ deposits affects ground water flow, sulphate dissolution and subsequent development of karst terrain.

Renewed interest in the area (*i.e.* the Airstrip property) beginning in the late 1980s has revealed a probable tonnage of a few hundred thousand tonnes of gypsum-bearing material ranging form 80 to 95% gypsum. The development of the karst terrain is considered to have links to the distribution of gypsum resources throughout the region (Figure 8).

It is suggested that areas characterized by an abundance of shale and related fine-grained clastic sedimentary rocks may be better exploration targets for more massive, higher-grade gypsum deposits. Shaley material enveloping gypsum units would have tendency to protect them from dissolution by circulating groundwater. Areas associated with extensive development of sink holes and related karst features appear to contain variable fine-to medium-grained clastics with gypsum generally disseminated as a matrix and other secondary features (*i.e.* veins etc.) Clastic-dominated areas tend to form resistant stack or chimney structures. Those areas with a greater proportion of gypsum and coarser clastics tend to be associated with solution collapse structures varying in size. The amount of dissolution will depend on the $CaSO_4$ saturation levels in circulating ground

water, the distribution of coarse-and fine-grained clastics and the nature of disseminated gypsum.

Using this deposit model as a guide there appears to be at least three alternative gypsum-exploration sites with in the Plaster Rock Basin. These are all to the east and within several kilometers of Plaster Rock in areas considered reasonably accessible.

Acknowledgements:

The writer wishes to acknowledge with gratitude the contributions of Terry Leonard and Ken Mersereau, of the Geological Survey Branch's Mineral Deposits Section. Terry and Ken capably prepared most of the figures and accompany this report. Thanks are also extended to Les Fyffe , D.V. Venugopal and Barbara Carroll also of the Geological Surveys Branch for their review and constructive comments. A special thank you is addressed to Mr. Dan F. Merrithew, president of Plaster Rock Gypsum and Manufacturing who permitted his geotechnical information on his Airstrip gypsum property to be included in parts of this report

BIBLIOGRAPHY

ANNUAL REPORTS OF THE CROWN LAND DEPARTMENT (Government of New Brunswick)., 1875, p. ix; 1876, p. ix; 1892, p. vii; 1894, pp. C-9 to C-10; 1900, p. C-5; 1909;, p. xxvii; 1910, p. xxi; 1911, pp. xxi-xxii, 1917, p. 32.

ANNUAL REPORTS OF THE DEPARTMENT OF LANDS AND MINES (Government of New Brunswick), 1928, p. 57; 1930, p.48; 1931, p.38.

BAILEY, L.W., 1864. Report on the mines and minerals of New Brunswick, with an account of the present mining operations in the province. Queens Printer, Fredericton, New Brunswick, pp.6-7.

BAILEY, L.W., 1885. Report on explorations and surveys in portions of the counties of Carleton, Victoria, York and Northumberland, New Brunswick. Geological and Natural History Survey of Canada, Geological Survey of Canada, Annual Report, Part N, p. 6-7.

BAILEY, L.W., 1886. Report on explorations and surveys in portions of the counties of Carleton, Victoria, York and Northumberland, New Brunswick. Geological and Natural History Survey of Canada, Geological Survey of Canada Annual Report for 1885, Part G, p. 30.

BAILEY, L.W., 1888. Report on explorations and surveys in portions of the counties of Carleton, Victoria, York and Northumberland, New Brunswick. Geological and Natural History Survey of Canada, Geological Survey of Canada Annual Report for 1887, Part 1 G, pp. 29-30.

BAILEY, L.W., 1898. The mineral resources of the Province of New Brunswick. Geological Survey of Canada, Summary Report 1897, Volume 10, Part M, pp. 100M - 101M.

BAILEY, L.W. and JACK, B., 1880. The useful minerals of New Brunswick. Fredericton, N.B. p. 45.

BAILEY, L.W. and JACK, B., 1906. The gypsum deposits of New Brunswick. Royal Society of Canada, Transactions 12(4), Second Series, pp. 3-14.

BAILEY, L.W. and McINNES, W., 1887. Report on explorations and surveys in portions of the counties of Carleton, Victoria, York and Northumberland, New Brunswick. Geological and Natural History Survey of Canada, Geological Survey of Canada Annual Report for 1886, Part N, p. 19.

BOUCOT, A.J., FIELD, M.T., FLETCHER, R., FORBES, W.H., NAYLOR, R.S. and PAVLIDES, L., 1964. Reconnaissance bedrock geology of the Presque Isle quadrangle, Maine. Maine Department of Economic Development, Maine Geological Survey, Quadrangle Mapping Series, No. 2, p. 123.

BRADLEY, H., 1984. History of Foreston, Carleton County, New Brunswick, including adjacent communitites of Biggar Ridge and Beaufort. Hartland Publishers, Hartland, New Brunswick, p. 23.

BRUMELL, H.P., 1888. Report on mining and mineral statistics of Canada for the year 1888. Geological and Natural History Survey of Canada, Geological Survey of Canada Annual Report for 1888, Part S, p. 38.

CIM 1998., International reserves definition initiative. Canadian Institute of Mining and Metallurgy Bulletin, Vol.90, No. 1017, pp. 44-45.

COLE, L.H. 1913. Gypsum in Canada: its occurrence, exploration and technology. Canada Department of Mines, Mines Branch, No. 245, pp. 43-44.and p. 46

COLE, L.H. 1930., The gypsum industry of Canada. Canada Department of Mines, Mines Branch, No. 714, pp. 22-23.

COSTE, E., 1887. Report on mining and mineral statistics of Canada. Geological and Natural History Survey of Canada for the year 1886, Geological Survey of Canada Annual Report for 1886, Part S, p. 35.

COSTE, E., 1888. Report on mining and mineral statistics of Canada for the year 1887. Geological and Natural History Survey of Canada, Geological Survey of Canada Annual Report for 1887, Part S, p. 31.

CROSBY, R., 1996. 1995 Final report for trenching and drilling on the Airport Claims, Plaster Rock area, Victoria County, New Brunswick. New Brunswick Exploration Assistance Program, New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division, unpublished report, 11p. (with maps).

DAVIES, J.L., 1979. Geological map of northern New Brunswick. New Brunswick Department of Natural Resources, Mineral Resources Branch, Map NR-3.

EDGAR, J., 1860. New Brunswick as a home for emigrants: with the best means of promoting immigration and developing the resources of the province. (microform)Saint John, N.B. (?), printed by Barnes and Co. , 37p.

ELLS, R.W. 1881., Report on the geology of northern New Brunswick, embracing portions of the counties of Restigouche, Gloucester, and Northumberland. Geological and Natural History Survey of Canada, Geological Survey of Canada Report of Progress 1879-80, Part D, p.46.

ELLS, R.W., 1907. The geology and mineral resources of New Brunswick. Canada. Department of Mines, Geological Surveys Branch, No. 983, pp. 121-122.

FITZHERBERT, C., 1992. Gypsum – the rock of Plaster Rock? In The Cataract, February 5, Grand Falls, New Brunswick, Section B, p. 10.

FOLKINS, T., 2000. Gypsum mining back in Plaster Rock. In Business, Section C, Telegraph Journal, November 23, 2000, pp. C1-C2.

FRASER, D.M., 1999. Feasibility study: Plaster Rock Gypsum and Manufacturing Limited. (unpublished and confidential report; excerpts used with permission of Daniel F. Merrithew of Plaster Rock Gypsum and Manufacturing Limited), p. 32.

FYFFE, L.R.,1982a. Geological compilation of Andover, Carleton and Victoria counties (21J/12). New Brunswick Department of Natural Resources and Energy, Mineral Resources, Map Plate 84-313.

FYFFE, L.R., 1982b. Geological compilation of Aroostook, Victoria County (21J/13). New Brunswick Department of Natural Resources and Energy, Mineral Resources, Map Plate 84-314.

FYFFE, L.R., 1982c. Geological compilation of Plaster Rock, Victoria County (21J/14). New Brunswick Department of Natural Resources and Energy, Mineral Resources, Map Plate 84-315.

FYFFE, L.R., 1982d. Geology of Woodstock (Sheet 21 J). New Brunswick

Department of Natural Resources and Energy, Mineral Resources, Map NR-4.

GESNER, A., 1843. Fifth report on the Geological Survey of the Province of New Brunswick. printed by Henry Chubb, Saint John, N.B., p. 62.

GOODWIN, D.Sc., 1928. Geology and minerals of New Brunswick. Industrial and Educational Publishing Company, Gardenvale, Quebec, p. 50.

HAMILTON, J.B. and BARNETT, D. E., 1970. Gypsum in New Brunswick. New Brunswick Department of Natural Resources, Mineral Resources Branch, Report of Investigation 10, pp. 12-16.

HANNAY, H., 1902. New Brunswick (Canada): Its resources and advantages. Note: published by the Crown Land Department of the Province of New Brunswick, Fredericton, N.B., p. 62.

HAYES, W.H., 1929. The geography of New Brunswick. Unpublished MSc thesis, Cornell University, Ithica, New York, p. 53.

HIND, H.Y. 1865. A preliminary report on the geology of New Brunswick, together with a special report on the distribution of the "Quebec Group" in the province. Juornal of the House of Assembly, Appendix 8, p. 63.

INGALL, E.D., 1891. Mineral statistics and mines. Annual report for 1890. Geological Survey of Canada, Part S, p. 77.

INGALL, E. D., 1893. Mineral statistics and mines. Annual report for 1891. Geological Survey of Canada, Part SS, pp. 74-75.

INGALL, E. D., 1898. Mineral statistics and mines. Annual report for 1898. Geological Survey of Canada, Part S, p. 79.

IRRINKI, R.R., 1977a. Geology of the Tobique-Bald Mountain-Riley and Neary brooks map area, J-10 (21O/3E). New Brunswick Department of Natural Resources and Energy, Mineral Resource, Map Plate 77-10.

IRRINKI, R.R., 1977b. Geology of the South Branch Gulquac River, j-12 (21J/14E). New Brunswick Department of Natural Resources and Energy, Mineral Resource, Map Plate 77-12.

JENNISON, W.F., 1911. Report on gypsum deposits of the Maritime Provinces. Canada Department of Mines, Mines Branch No.84, pp. 90-91.

KRAMM, H.E., 1912. Gypsum of New Brunswick. Canada Department of Mines, Geological Survey Branch, Summary Report for 1911, pp. 324-325.

MADORE, T. and YOEMANS, E.. c.1985. A legacy of Plaster Rock. p. 15 and p. 230.

MCLEISH, J. 1917., Mineral production of Canada during the calendar year 1915. Canada Department of Mines, Mines Branch No. 426, p. ?

McLEISH, J., 1910. Annual report of the Division of Mineral Resources and Statistics on mineral production of Canada during the calendar years 1907 and 1908. Canada Department of Mines, Mines Branch No. 58, p. ?

McLEISH, J., 1918. Annual report of mineral production of Canada during the calendar year 1916. Canada Department of Mines, Mines Branch No. 474 p. ?

MERRITHEW, D.F., 1991. Airfield Group. Department of Natural Resources and Energy, Minerals and Energy Division, Mineral Exploration Report of Work, Assessment File 474146, p. 2.

NEW BRUNSWICK DEPARTMENT OF NATURAL RESOURCES AND ENERGY, 2000. Bedrock Geology of New Brunswick, Minerals and Energy Division, Map NR-1 (2000 edition), Scale 1:500 000.

OLMSTEAD, E., 1978. "He was a great old promoter" In The Tobiquer, No.1, April 1978, pp. 48-49.

ROSE, B., 1936. Preliminary report – Plaster Rock area, New Brunswick. Geological Survey of Canada, Paper 36-19, p. 10.

ROY, D.C. and MENCHER, E. ,1976. Ordovician and Silurian stratigraphy of northeastern Aroostook County, Maine. Geological Society of America, Memoir 148, p. 25-52.

ST. PETER, C., 1978. Geology of head of Wapske River, map area J-13 (21 J/14). New Brunswick Department of Natural Resources and Energy, Mineral Resources Branch, Map Report 78-1, p. 24.

ST. PETER, C., 1979. Geology of Wapske-Odell River-Arthurette region, New Brunswick, Map areas I-13, I-14, H-14 (parts of 21J/11, 21 J/12, 21 J/13, 21 J/14). New Brunswick Department of Natural Resources and Energy, Mineral Resources Branch, Map Report 79-2, p. 32.

SKINNER, R., 1971. Plaster Rock map area, New Brunswick. In Report of Activities, Part A, April to October, Geological Survey of Canada, Paper 71-1, pp. 13-16.

SKINNER, R., 1975. Geology of Tuadook Lake map area, New Brunswick. Geological Survey of Canada, Paper 74-33, 9 p.

SKINNER, R. 1975. Geology of the Plaster Rock (east half) map area, New Brunswick. Geological Survey of Canada, Paper 81-8, 16 p.

STEAD, G., 1893. Article I. Notes on the geography and natural history of the Tobique. Bulletin of the Natural History Society, No. XI, pp. 19-32

SUND, J.O., 1958. Origin of New Brunswick gypsum deposits. Unpublished MSc thesis, University of New Brunswick, Fredericton, N.B. pp. 38-60.

SUND, J.O., 1959. Origin of New Brunswick gypsum deposits. Canadian Institute of Mining and Metallurgy Transactions 62, pp. 395-400; and Canadian Institute of Mining and Metallurgy Bulletin 571, pp. 707-712.

WEBB, T.C., 1997. Carboniferous limestone of New Brunswick: geology and development potential. New Brunswick Department of Natural Resources and Energy, Minerals and Energy Division, Open File Report 97-7, pp. 95-100.

WEBB, T.C., 1977. Gypsum and related deposits of New Brunswick. New Brunswick Department of Natural Resources, Mineral Resources Branch, Topical Report 77-6, pp. 45-46.

WEBB, T.C. and KINGSTON, P.W., 1975. Limestone and gypsum resources of Plaster Rock, Victoria County. New Brunswick Department of Natural Resources, Mineral Resources Branch, T.R. 75-14, p, 13.

WEBB. T.C. and VENUGOPAL, D.V., 1992. A preliminary assessment of the geology and mineral resources of the Plaster Rock Basin and adjacent area, Victoria County, New Brunswick. New Brunswick Department of Natural Resources and Energy, Minerals Resources, Open File Report 92-4, p. 48.

APPENDIX A

Compiled chemical analyses of typical gypsum samples, for the Plaster Rock area, Victoria County, northwestern New Brunswick (1911-1992).

APPENDIX B

Summary of drilling activity on the Airstrip gypsum property near Plaster Rock, Victoria County, northwestern New Brunswick

Appendix A. Compiled chemical analyses for typical gypsum samples from the Plaster Rock area, Victoria County, northwestern New Brunswick.

Source	Insol.	Fe_2O_3	SiO_2	Al_2O_3	CaO	MgO	SO_4/SO_3	H_2O	Total	$CaSO_4 \cdot 2H_2O$	Remarks
Cole (1930)	0.7.36	0.61	-	2.09	29.56	0.84	39.54/-	18.08	99.25	86.39	Exact location unknown
Jennison (1911)	8.86	-	-	2.72	21.92	1.96	38.21/-	17.80	-	85.06	Exact location unknown
	1.18	-	-	9.80	28.95	Trace	41.06/-	18.45	-	88.16	Exact location unknown
Hamilton and Barnett (1970)	-	1.38	19.51	4.46	25.67	4.11	-/29.11	13.83	99.54	-	Exact location unknown
	-	1.33	15.83	4.66	27.81	1.67	-/31.87	15.27	99.24	-	Exact location unknown
	-	1.08	13.80	3.79	28.00	1.86	-/34.73	15.87	99.83	-	Exact location unknown
Venugopal and Webb (1992)	-	0.34	1.80	0.54	29.78	0.36	51.77/-	18.79	-	91.84	See sample # SB-GYP-1-90, Map Plate 92-50B for location
	-	0.34	4.00	0.66	28.66	0.58	51.84/-	18.32	-	90.64	See sample # WPK-GYP-11-90, Map Plate 92-50B for location

Appendix B. Summary of drilling activity on the Airstrip gypsum property near Plaster Rock, northwestern New Brunswick (Venugopal and Webb 1992 and Crosby 1996).

Drill Hole (year-#)	Overburden thickness (meters)	Total depth (meters)	Drill core recovered (meters / %)	Sampled; interval /core length (meters)	$\%CaSO_4(dry)$[1] / % gypsum[2] (e-estimate)	Remarks
90-1[1]	?	6.09	None	90-1A (0-1.52)	85.60/-	Exact hole locations unknown. Powdered samples from air-track drill, some sample contamination expected.
				90-1B (1.52-3.04)	78.75/-	
				90-1C (3.04-4.57)	50.26/-	
				90-1D (4.57-6.09)	47.37/-	
90-2	?	6.09	None	(0-6.09)	85.81/-	
90-3	?	12.19	None	90-3A (0-6.09) [top of hole?]	71.44/-	
				90-3B (0-6.09) [bottom of hole?]	74.21/-	
				90-3C (6.09-9.14)	61.56/-	
				90-3D (11.58-12.19)	44.47/-	
90-4	?	9.14	None	6.09-9.14	40.05/-	
90-5	?	12.19	None	0-12.19	53.34/-	
90-7	?	2.74	None	0-2.74	75.48/-	
90-8	?	1.52	None	0-1.52	75.46/-	
90-10	?	1.83	None	0-1.83	77.56/-	
90-11	?	10 .67	None	90-11A (0-1.22)	70.01/-	
				90-11B (1.22-2.74)	70.76/-	
				90-11C (6.09-10.67)	77.41/-	
95-1[2]	0	8.23	1m /12.1%	1 m	-/50e	Significant core losses in some holes due to abrasive nature of drilling method. Uncertainty if core totally represents a continuous section of more resistant gypsum beds or is a composite of surviving gypsum with intervening beds of siltstone, shale and /or gypsiferous shale lost. All grades visually estimated.
95-2	0	8.23	2.6m / 31.6	2.6m	-/50e	
95-3	8.23	8.23	-	?	-	
95-4	6.10	8.23	1.54m / 72.	1.54m	-/65e	
95-5	0	8.23	2.62m / 31.8	2.62m	-/88e	
95-6	2.74	8.23	5.49m / 77.0	2.74-5.79 (3.05m)	-/90e	
				7.01-8.23 (1.22m)	-/75e	
95-7	4.57	6.10	0.7m / 45.6	0.7m	-/65e	
95-8	8.23	8.23	-	-	-	
95-9	0	14.63	9.29 / 63.5	0-13.53 (8.19m)	-/80e	
				13.53-14.63 (.45m)	-/75e	
95-10	0	14.63	7.32 / 50.0	0-5.49 (5.49m)	-/45e	
				5.49-6.40 (0.91m)	-/98e	
				6.40-7.32 (0.92m)	-/85	
95-11	7.62	7.62	-	-	-	
95-12	0	6.10	3.05 / 50.0	3.05m	-/75e	
95-13	6.10	6.10	-	-	-	
95-14	3.66	7.62	2.61 / 66.0	2.61m	-/25e	
95-15	0.61	14.63	9.14 / 62.5	0.61-8.08 (7.87m)	-/35e	
				8.08-9.14 (1.06m)	-/98e	
95-16	0.61	14.63	5.47 / 20.8	4.27m	-/82e	
95-17	0	14.63	7.31 / 50.0	7.31m	-/85e	

[1] Merrithew 1991
[2] Crosby 1996

Appendix B (continued). Summary of drilling activity on the "Air Strip" Property Plaster Rock area, Victoria County, northwestern New Brunswick (Venugopal and Webb 1992 and Crosby 1996).

Drill Hole (year-#)	Overburden thickness (meters)	Total depth (meters)	Drill core recovered (meters / %)	Sampled; interval /core length (meters)	%$CaSO_4$(dry)[3] / % gypsum[4] (e-estimate)	Remarks
95-18[2]	0	14.63	5.49 / 37.5	5.49m	-/50e	Significant core loss in some holes due to abrasive nature grinding of core during drilling method. Uncertainty if core represenrts continuous section of more resistant gypsum or is a composite of surviving gypsum cores with intervening beds of siltstone, ,shale and /or gypsiferous shale lost
95-19	0	14.63	None	-	-	
95-19A	0	14.63	None	-	-	
95-19B	0	14.63	None	-	-	
95-20	0.30	14.63	1 / 6.8	1m	-/75e	
95-21	9.14	9.14	-	-	-	
95-22	9.14	9.14	-	-	-	
95-23	9.14	9.14	-	-	-	
95-24	0	14.63	2.31 / 15.8	2.31m	-/77e	
95-24A	0.15	14.63	2.60 / 18.0	0.15-3.35 (1.35m)	-/80e	
				5.47-14.63 (1.25m)	-/45e	
95-25	0	9.14	None	-	-	
95-26	0	14.63	9.75 / 66.6	0-1.83 (1.83m)	-/85e	
				1.83-9.75 (7.92m)	-/95	
95-27	-	-	-	-	-	
95-28	2.44	14.63	7.01 / 51.3	7.01m	-/78	
95-29	-	-	-	-	-	

[3] Merrithew 1991
[4] Crosby 1996

Appendix C

Map Plate 2001-25. Carboniferous geology and gypsum resources of the Plaster Rock area (part of NTS 21 J/14), Victoria County, northwestern New Brunswick.